

Energy Budgets of the Giant Planets and Titan

Liming Li, Mark A. Smith, Barney J. Conrath, Peter J. Conrath, Amy A. Simon-Miller,
Kevin H. Baines, Robert A. West, Richard K. Achterberg, Glenn S. Orton,
Santiago Perez-Hoyos, Harold J. Trammel, Don Banfield, Xun Jiang, Conor A. Nixon,
Gordon L. Bjoraker, Andrei A. Mamoutkine, Marcia E. Segura, Nicolas, J. P. Gorius,
F. Michael Flasar, Gianrico Filacchione, Patrick M. Fry, Thomas W. Momary,
Andrew P. Ingersoll, Carolyn C. Porco, Ashwin R. Vasavada, Anthony D. Del Genio,
Shawn P. Ewald

ABSTRACT

As a fundamental property, the energy budget affects many aspects of planets and their moons, such as thermal structure, meteorology, and evolution. We use the observations from two Cassini spectrometers (i.e., CIRS and VIMS) to explore one important component of the energy budget – the total emitted power of Jupiter, Saturn, and Titan (Li et al., 2010, 2011, 2012). Key results are:

- (1) The Cassini observations precisely measure the global-average emitted power of three bodies: $14.10 \pm 0.03 \text{ Wm}^{-2}$, $4.952 \pm 0.035 \text{ Wm}^{-2}$, and $2.834 \pm 0.012 \text{ Wm}^{-2}$ for Jupiter, Saturn, and Titan, respectively.
- (2) The meridional distribution of emitted power displays a significant asymmetry between the northern and southern hemispheres on Jupiter and Saturn. On Titan, the meridional distribution of emitted power is basically symmetric around the equator.
- (3) Comparing with the Voyager measurements, the new Cassini observations reveal a significant temporal variation of emitted power on both Jupiter and Saturn: i) The asymmetry between the two hemisphere shown in the Cassini epoch (2000-2010) is not present in the Voyager epoch (1979-1980); and ii) From the Voyager epoch to the Cassini epoch, the global-average emitted power appeared to increase by $\sim 3.8\%$ for Jupiter and $\sim 6.4\%$ for Saturn.
- (4) Together with previous measurements of the absorbed solar power on Titan, the new Cassini measurements of emitted power provide the first observational evidence of the global energy balance on Titan. The uncertainty in the previous measurements of absorbed solar energy places an upper limit on its energy imbalance of 6.0% on Titan.

The exploration of emitted power is the first part of a series of studies examining the temporal variability of the energy budget on the giant planets and Titan. Currently, We are measuring the absorbed solar energy in order to determine new constraints on the energy budgets of Jupiter, Saturn, and Titan.